



Combinatorial and geometric problems in imaging sciences

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Preface

Artificial Intelligence approaches and technologies are germane to various imaging science disciplines, including image analysis, image understanding, computer vision, medical imaging, biometrics, and robotics. These are in turn applicable to societally sensitive areas like medicine, defense, and security. The ultimate goal regarding possible applications is the design of intelligent computer systems capable of solving intricate practical problems. To this end, researchers often need to cope with challenging mathematical problems. The very nature of image analysis determines its close relation to various facets of artificial intelligence, where automated examination and decision making is needed.

This special issue contains papers on certain mathematical problems arising in image analysis and processing. Some of these contribute to the theory of digital and combinatorial geometry and topology, while others are application driven. After an open call, 13 papers were submitted; of them 8 were accepted for publication. Most of the submissions were substantially extended journal versions of the best papers presented in a special session of the *17th International Symposium on Artificial Intelligence and Mathematics (ISAIM 2022)* held in January 2022. All papers were thoroughly refereed by at least two reviewers, allowing for revision and improvement. As a result, only papers of very high quality are present in this publication. A brief review of the considered problems and obtained results is given next.

Fernando Díaz-del-Río, Helena Molina-Abril, Pedro Real, Darian Onchis, and Sergio Blanco-Trejo present an approach to developing homological calculus for 3D binary digital images. They construct an efficient parallel algorithm for exploring the topology of digital images, which is expected to be utilizable within machine learning methods for the classification and comparison of natural 3D images.

Müge Saadetoğlu, Benedek Nagy, and Aydın Avkan investigate the quality of rotations of objects in a digital grid. For this purpose, they introduce certain criteria and show that the triangular grid provides superior conditions compared to the square grid.

Somrita Saha and Arindam Biswas present a combinatorial technique for generation of a digital plane by shifting a 3D digital straight line segment. The proposed approach uses integer arithmetic, in particular based on classification of the plane normals.

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Timothy Petersen, Benjamin Cavy, David Paganin, and Imants Svalbe define families of new multi-level integer 2D arrays and study their properties. The introduced arrays extend to two dimensions the well-known binary Legendre sequences that are derived from quadratic residues.

T. Kalyani, S. Annadurai, T.T. Raman, and D.G. Thomas propose a method for generation of tetrahedral picture patterns. They compare the presented approach to the existing systems and discuss possible applications in tiling of tetrahedral patterns.

Niccolò Di Marco, Azzurra di Palma, and Andrea Frosini implement fractal dimension in analyzing the Alzheimer's disease changes that occur in white and gray brain matters. They define several neural network models and identify conditions under which these models reach their best performances.

Selim Reza, Marta Campos Ferreira, J.J.M. Machado, and João Manuel R.S. Tavares present a comparative study on sections of the road network of the city of Porto. They examine various factors, including degree distributions, clustering coefficients, centrality measures, connected components, k-nearest neighbors, shortest paths, community structures, and small-world analysis.

Jinwen Qiu, S. Rao Jammalamadaka, and Ning Ning propose a multivariate Bayesian time series model for performing multivariate time series analysis from a Bayesian machine learning perspective. The chosen approach allows taking advantage of the association structure among target series, simultaneously selecting important features and training the data-driven model.

We believe that the papers included in this special issue will be a useful reference for researchers in the area.

I would like to thank Professor Martin Golumbic, Editor-in-Chief of Springer's *Annals of Mathematics and Artificial Intelligence*, for the opportunity to organize and edit this issue. I am grateful to all authors who submitted their work. Sincere thanks go to the reviewers for their timely and high quality reviews. Finally, I acknowledge the assistance of Mr. Christian James Raguin, JEO Assistant of AMAI, for his cooperation during the reviewing process.

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